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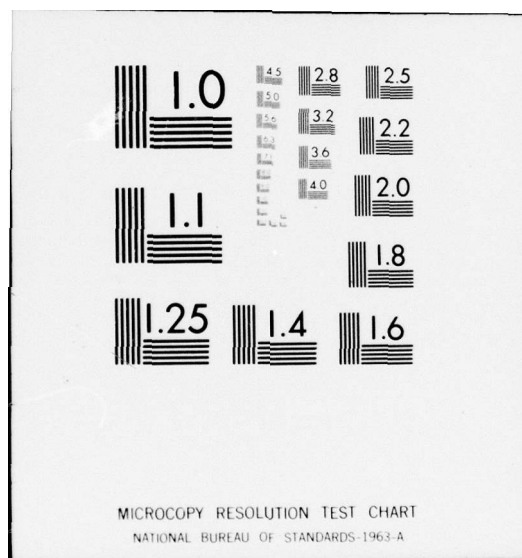
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However, when appearance is also considered, only one system was clean, smooth, and glossy after 2 years at Port Hueneme; two systems – one clean, smooth, and glossy, and the other, clean, smooth, and dull – had satisfactory appearance after 2 years at Kwajalein. In addition, two sets of coated blocks were stored at the Laboratory for 6 months to further coalesce before being exposed at Kwajalein. This procedure improved the waterproofing capability of one of the systems.

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INTRODUCTION

Because of the increased use of exposed aggregate concrete panels, brick, and natural stone in the exterior walls of buildings, there is a need for clear waterproof sealers which will preserve and protect the building and its contents from water damage. Because there are no Federal or Military specifications for clear waterproof sealers, the Commanding General, Marine Corps Base, Camp Pendleton, California, requested that the Civil Engineering Laboratory (CEL) perform necessary laboratory and field experiments "to define the necessary physical and chemical properties of a clear waterproof concrete and masonry sealer suitable for use at exterior exposures . . ."

EXPERIMENTAL

Coating Application

The substrates used for coating application were 4.1 x 19.6 x 40-cm (1-5/8 x 7-5/8 x 6-in.) concrete cap blocks.

A quantity of coating material in excess of that required for application to the specimens was transferred from its original container to a clean paper drinking cup. The cup, coating material, and paint brush to be used were weighed together before and after application of the coating to one 19.6 x 40-cm (7-5/8 x 6-in.) face of each block to determine the quantity of coating applied. Identification letters and/or numbers were marked on the opposite face. Approximately 24 hours later, a second coat of the same coating material was applied. The exception to the above procedures was two applications of a candidate coating material from an aerosol container. Details of the applications of 10 coating systems are listed in Table 1. Manufacturers of proprietary coatings are listed in Appendix A.

Selection of Coating Systems for Outdoor Exposure

Selection of those coating systems which would be placed on outdoor exposure at Port Hueneme, California, and Kwajalein, Marshall Islands, was made by subjecting the coated blocks described above and in Table 1 to the wind-driven rain test described in section 4.4.7 of Federal Specification TT-P-0035, except that three individual blocks were tested at one time rather than four blocks mortared together as described in the specification.

The apparatus, shown in Figure 1, consists of an acrylic plastic box, sources of water and air under regulated pressure, a clamping system, and a drain channel. Putty was used to seal the blocks over to the openings in the box; clamps held the blocks in place. The water flow was adjusted so that it struck the coated surfaces of the blocks evenly at a flow rate of 70 to 80 gph. The air supply was adjusted so that 5 inches of pressure was produced inside the apparatus as registered on a water manometer.

Details on the coating and initial screening of 10 candidate coating systems are shown in Table 1.

Those five coating systems which gained less than 90 grams (0.2 lb) of water per block in 24 hours were selected for outdoor exposure.

Outdoor Exposure of Coated Blocks

Blocks were coated in the same way as described above. Fifteen blocks, three replicates coated with each of five systems, were exposed at Port Hueneme and 15 were exposed at Kwajalein (Table 2). Six additional blocks, three coated with Aqua Peil® and three with TT-P-55b mixing liquid, were stored at CEL for 6 months to promote additional coalescing of the coatings before exposure at Kwajalein.

The 15 panels exposed in the southeast section of the CEL compound at Port Hueneme were inspected after 12 and 24 months and removed after 25 months. The surface appearances of these panels are summarized in Table 3.

The 15 panels exposed at Kwajalein were inspected after 18 months, removed after 24 months, and returned to CEL, where they were inspected. The surface appearances of these panels are summarized in Table 3.

The six panels which had been stored at CEL for 6 months before exposure at Kwajalein were inspected after 12 months of exposure, removed after 24 months, and returned to CEL, where they were inspected. The surface appearances of these panels are summarized in Table 3.

Wind-Driven Rain Tests of Exposed Panels

All panels that had been exposed at Port Hueneme and Kwajalein were subjected to the wind-driven rain test for 24 hours. The results are given in Table 4. Absorption of more than 90 grams (0.2 lb) of water by a block constitutes failure of this test.

FINDINGS

Four systems — TT-P-19b mixing liquid, TT-P-55b Type II mixing liquid, Aqua Peil®, and Advanced Aqua Seal® 5C-4 — passed the 24-hour wind-driven rain test after 2 years of outdoor exposure at Port Hueneme (Table 4). However, only blocks coated with TT-P-19b mixing liquid had a good surface appearance after 2 years. Four systems — TT-P-19b mixing liquid, TT-P-55b Type II mixing liquid, Advanced Aqua

Seal[®] 5C-4, and Rhoplex[®] SS-521 plus butyl cellosolve and water — passed the wind-driven rain test after 2 years of outdoor exposure at Kwajalein (Table 4). The Rhoplex[®] barely passed, however, and, thus, is not included with the other three systems which performed very well in the wind-driven rain test. When appearance is also considered, only TT-P-19b mixing liquid and Advanced Aqua Seal[®] 5C-4 would be considered satisfactory.

Allowing two systems, TT-P-55b Type II mixing liquid and Aqua Pell[®], to remain in the laboratory for 6 months to further coalesce before exposure did not markedly improve the waterproofing capability of TT-P-55b Type II mixing liquid, but did improve markedly that of Aqua Pell[®]. Cost data on the two acceptable coating materials are listed in Table 5.

RECOMMENDATIONS

Based on the exposure of concrete cap blocks coated with clear masonry sealers at Port Hueneme, California, and Kwajalein, Marshall Islands, for 2 years, followed by an inspection for surface appearance and by the wind-driven rain test, it is recommended that:

1. TT-P-19b mixing liquid be used in temperate regions with moderate rainfall, in tropical areas, or in areas of heavy rainfall.
2. Advanced Aqua Seal[®] 5C-4 be used in tropical areas or in areas of heavy rainfall.

ACKNOWLEDGMENTS

The authors thank Mr. Eddy S. Matsui for installing and inspecting the samples exposed at Kwajalein, and Messrs. Richard M. Staples and Theodore R. L. Tree for performing the wind-driven rain tests.

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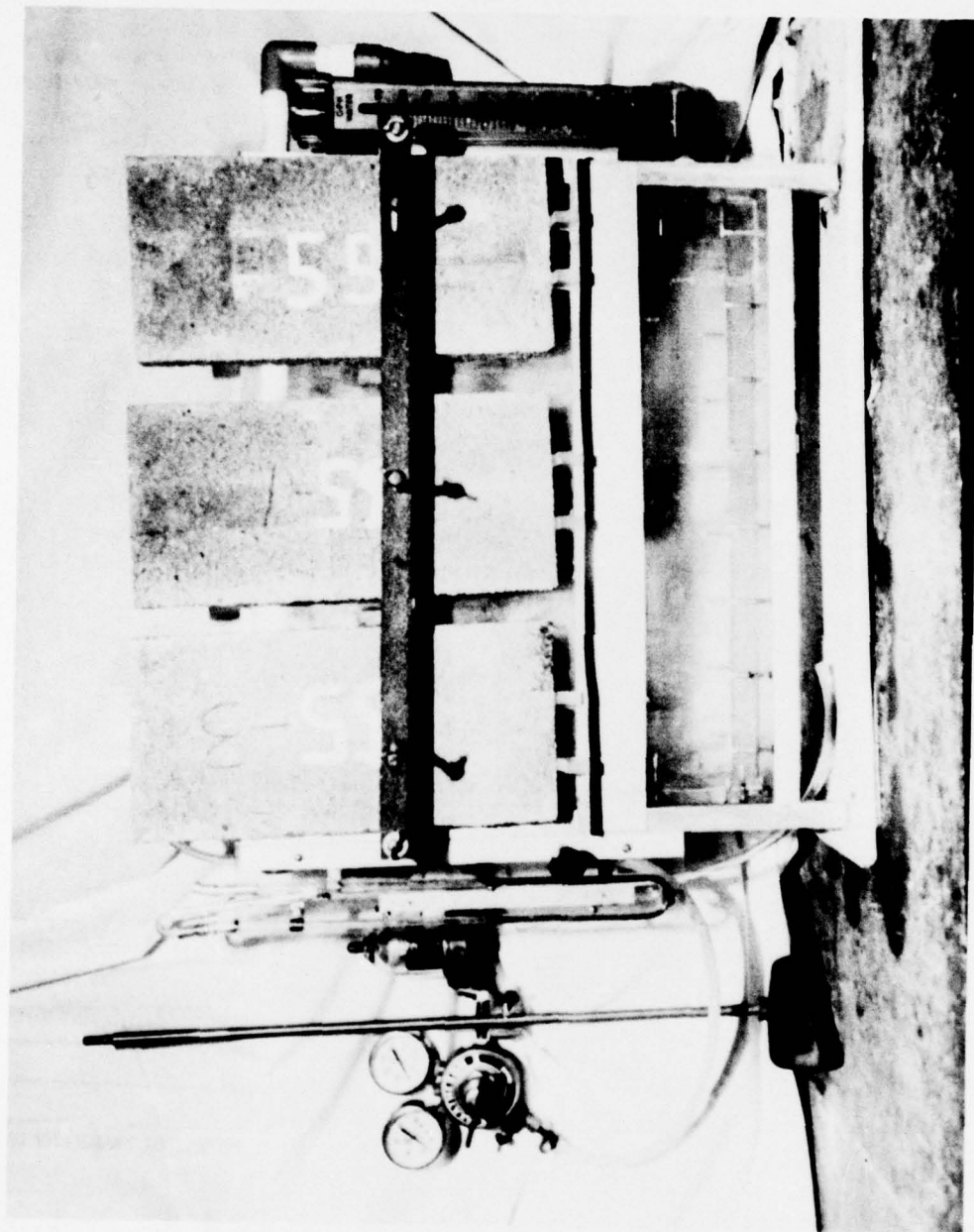


Figure 1. Wind-driven rain machine with three coated concrete cap blocks in place.

Table 1. Initial Screening of Clear Waterproof Sealers for Masonry

Coating System	Specific Gravity, g/cm (lb/gal)	Weight of Coating (g)		Coverage Rate, m ² /l (sq ft/gal)		Appearance	
		First Coat	Second Coat	First Coat	Second Coat	Wet Block	
Aqual Pell [®]	1.08 (9.01)	32.8 32.2	13.1 12.5	2.6 (105) ^b 2.6 (105) ^b	6.4 (263) ^b 6.7 (274) ^{b,c}	Whitened. Mostly gone in 6 to 7 hr. Might be quite unsightly.	N G
Advanced Aqua Seal [®] 5C-4	1.05 (8.76)	31.7 30.6	16.9 17.1	2.6 (105) 2.7 (109)	4.8 (197) 4.8 (197)	Slightly whitened.	N G
Chem Stop [®] HD	0.8 (6.61)	25.5 28.7	28.0 29.5	2.4 (100) 2.2 (89)	2.2 (91) 2.1 (86)	Soaked through.	N
Federal Spec SS-S-1416	0.86 (7.15)	28.5 29.5	22.1 19.7	2.4 (96) ^d 2.3 (93) ^d	3.0 (124) 3.4 (139) ^c	Soaked through.	D
Super Kote [®] Clear	0.9 (7.5)	38.9 33.7	17.1 22.2	1.8 (74) ^e 2.1 (85) ^e	4.1 (167) 3.2 (129)	Soaked through	N
Federal Spec TT-P-19b mixing liquid	0.9 (7.5)	27.8 27.3	13.9 12.4	2.5 (103) 2.6 (105)	5.1 (206) 5.7 (230)	Uniform whitening, which faded in 3 to 4 hr.	N G
Federal Spec TT-P-55b Type II mixing liquid	1.01 (8.4)	26.2 29.5	12.3 12.8	3.0 (123) 2.7 (109)	6.4 (261) 6.1 (250)	Uniform slight whitening.	N G
Rhoplex [®] SS-521 (400), butyl cellosolve (40), water (26) (latter two premixed)	0.96 (8.0)	32.3 31.6	11.8 10.6	2.3 (95) ^b 2.4 (97) ^b	6.3 (258) 7.1 (289) ^c	No whitening.	N G
Rhoplex [®] SS-521 (202), butyl cellosolve acetate (20), water (13)	0.96 (8.0)	48.4 48.4	5.9 5.9	1.5 (63) 1.5 (63)	12.8 (521) 12.8 (521)	No whitening. Soaked through.	N G
Hydropell [®] 1200		two spray coats from aerosol container				Soaked through.	N N

^aWeight to nearest 28 g (0.06 lb).^bDifficult to apply at this rate on a vertical wall.^cBlock less porous than other.^dBarely covers at this rate because of difficulty in spreading.^eWill not cover at the manufacturer's recommendation of 200 sq ft/gal on first coat.

2

Screening of Clear Waterproof Sealers for Masonry

Rate, m ² /l (sq ft/gal)	Appearance After Coating			Water Gain From Wind-Driven Rain Test ^a
	Second Coat	Wet Block	Dry Block	
6.4 (263) ^b 6.7 (274) ^{b,c}	Whitened. Mostly gone in 6 to 7 hr. Might be quite unsightly.	No color change. Glossy.	Smooth, completely filled.	<90 g (0.2 lb) in 24 hr. <90 g (0.2 lb) in 24 hr.
4.8 (197) 4.8 (197)	Slightly whitened.	No color change. Glossy.	Smooth, completely filled.	<90 g (0.2 lb) in 24 hr. <90 g (0.2 lb) in 24 hr.
2.2 (91) 2.1 (86)	Soaked through.	No change.	No change.	Leaked badly. Gained 28 g (0.06 lb) in 15 min. Leaked immediately. Gained 84 g (0.19 lb) in 20 min.
3.0 (124) 3.4 (139) ^c	Soaked through.	Darkened considerably.	No change.	>90 g (0.2 lb) in 5 min.
4.1 (167) 3.2 (129)	Soaked through	No change.		>90 g (0.2 lb) in 5 min.
5.1 (206) 5.7 (230)	Uniform whitening, which faded in 3 to 4 hr.	No color change. Glossy.	Smooth, filled.	<90 g (0.2 lb) in 20 hr.
6.4 (261) 6.1 (250)	Uniform slight whitening.	No change. Glossy.	Smooth, filled	<90 g (0.2 lb) in 23 hr.
6.3 (258) 7.1 (289) ^c	No whitening.	No color change. Glossy as no. 2.	Smooth, completely filled.	<90 g (0.2 lb) in 24 hr.
12.8 (521) 12.8 (521)	No whitening. Soaked through.	No color change Glossy as no. 2.	Smooth, completely filled.	>135 g (0.3 lb) in 24 hr. >135 g (0.3 lb) in 24 hr.
	Soaked through.	No color change. No gloss.	No change.	>90 g (0.2 lb) in 5 min.

Table 2. Coated Cap Blocks for Outdoor Exposure

Coating System	Weight of Coating (g)		Coverage Rate, m ² /l (sq ft/gal)	
	First Coat	Second Coat	First Coat	Second Coat
Kwajalein Exposure Site				
Advanced Aqua Seal [®] 5C-4	28.4	11.0	2.9 (118)	7.4 (303)
	34.5	14.9	2.4 (97)	5.5 (224)
	25.9	11.4	3.2 (129)	7.2 (292)
Aqua Pell [®]	26.8	14.3	3.1 (128)	5.9 (240)
	23.9	11.5	3.5 (144)	7.4 (300)
	28.0	11.3	3.0 (123)	7.4 (303)
Rhoplex [®] SS-521 + butyl cellosolve + water	35.1	13.9	2.1 (87)	5.4 (219)
	36.1	13.6	2.0 (83)	5.5 (224)
	34.2	13.4	2.2 (89)	5.6 (227)
Federal Spec TT-P-19b mixing liquid	26.5	11.8	2.7 (108)	6.0 (243)
	22.1	12.3	3.2 (129)	5.7 (232)
	22.3	13.6	3.1 (128)	5.2 (211)
Federal Spec TT-P-55b, Type II mixing liquid	27.9	15.5	2.8 (115)	5.1 (208)
	30.2	15.3	2.6 (106)	5.2 (211)
	24.8	14.1	3.2 (129)	5.6 (227)
Port Hueneme Exposure Site				
Advanced Aqua Seal [®] 5C-4	26.8	17.2	3.1 (125)	4.8 (194)
	25.8	18.3	3.2 (129)	4.5 (183)
	26.1	16.9	3.1 (128)	4.8 (199)

continued

Table 2. Continued

Coating System	Weight of Coating (g)		Coverage Rate, m ² /l (sq ft/gal)	
	First Coat	Second Coat	First Coat	Second Coat
Aqua Pell [®]	34.4	12.0	2.4 (100)	7.0 (286)
	33.2	12.5	2.5 (104)	6.7 (274)
	39.0	15.7	2.2 (88)	5.4 (219)
Rhoplex [®] SS-521 + butyl cellosolve + water	34.1	13.3	2.2 (90)	5.6 (229)
	37.7	14.7	2.0 (81)	5.1 (208)
	37.4	13.2	2.0 (82)	5.7 (230)
Federal Spec TT-P-19b mixing liquid	33.6	13.3	2.1 (85)	5.3 (215)
	37.3	14.7	1.9 (77)	4.8 (195)
	33.3	13.0	2.1 (86)	5.4 (221)
Federal Spec TT-P-55b, Type II mixing liquid	37.0	14.4	2.1 (87)	5.5 (222)
	35.5	14.4	2.2 (91)	5.5 (222)
	36.0	16.8	2.2 (89)	4.7 (192)

Table 3. Surface Appearance of Cap Blocks After Exposure Periods

Exposure Site	Time Period	Coating System				
		Federal Spec TT-P-19b Mixing Liquid	Federal Spec TT-P-55b, Type II Mixing Liquid	Aqua Pell [®]	Advanced Aqua Seal [®] 5C-4	Rhoplex [®] SS-521 + Butyl Cellosolve + Water
Port Hueneme	1 yr	Slightly dirty, gray brown. Slightly dirty. Very slightly dirty.	Dirty, brown. Dirty, brown. Moderately dirty, brownish gray.	Moderately dirty, brown. Moderately dirty, brown. Slightly dirty.	Dirty, gray-brown. Moderately dirty. Moderately dirty.	Clean. Clean. Clean.
	2 yr	Clean, smooth, glossy. Clean, smooth, glossy. Clean, smooth, glossy.	Dirty, gritty, brown, med dense blistering. Dirty, gritty, brown, med dense blistering. Discolored, gritty, med dense blistering.	Dirty, gritty, slightly discolored. Slightly dirty, slightly gritty, slightly discolored. Slightly gritty, slightly discolored.	Dirty, gritty, grayish. Gritty, discolored. Gritty, discolored.	Clean, smooth, glossy. Clean, smooth, glossy. Clean, smooth, glossy.
Kwajalein	18 mo	Clean, light chalking, rough, low gloss. Clean, light chalking, rough, low gloss. Clean, light chalking, rough, low gloss.	Clean, rough, slightly discolored, high gloss. Clean, rough, slightly discolored, high gloss. Clean, light chalking, rough, slightly discolored, high gloss.	Clean, rough, semigloss. Clean, rough, semigloss. Clean, rough, semigloss.	Clean, smooth, semigloss. Clean, smooth, semigloss. Clean, smooth, semigloss.	Clean, smooth, high gloss. Clean, smooth, high gloss. Clean, smooth, high gloss.
	2 yr	Clean, smooth, glossy. Clean, smooth, glossy. Clean, smooth, glossy.	Clean, smooth, semigloss. Tacky, smooth, glossy. Tacky, smooth, glossy.	Clean, rough, dull. Clean, rough, dull. Clean, rough, dull.	Clean, smooth, dull. Clean, smooth, dull. Clean, smooth, dull.	Clean, smooth, glossy. Clean, smooth, glossy. Clean, smooth, glossy.
Kwajalein ^a	1 yr		Clean, smooth, high gloss. Clean, smooth, high gloss. Clean, smooth, high gloss.	Clean, rough, moderate blistering, semigloss. Clean, rough, semigloss. Clean, rough, light blistering, semigloss.		
	2 yr		Clean, smooth, semigloss. Clean, smooth, semigloss. Clean, smooth, semigloss.	Clean, smooth, semigloss. Clean, smooth, semigloss. Clean, smooth, semigloss.		

^a Blocks stored for 6 months before exposure.

Table 4. Weight Gain of Coated Cap Blocks After
a 24-Hour Wind-Driven Rain Test^a

Coating System	Weight Gain (g) for Blocks Exposed at -		
	Port Hueneme	Kwajalein	Kwajalein (after 6 mo at CEL)
Federal Spec TT-P-19b mixing liquid	1	1	
	159, 32 ^b	0	
	25	64, 5 ^b	
Federal Spec TT-P-55b, Type II mixing liquid	49	131, 88 ^b	68
	15	24	44
	7	26	35
Aqua Pell [®]	9	84	1
	2	107	42
	0	134	1
Advanced Aqua Seal [®] 5C-4	16	2	
	25	7	
	42	5	
Rhoplex [®] SS-521 + butyl cellosolve + water	166	90	
	162	75	
	125	38	

^aBlocks were exposed for 2 years at test sites.

^bTest repeated on these blocks with this result.

Table 5. 1976 Costs of Clear, Waterproof Masonry Sealers

Material	Quantity (gal)	Container Size (gal)	\$/gal ^a (FOB)	Supplier
Federal Spec TT-P-19b mixing liquid	50	5	5.75	Proline Paints 2646 Main San Diego, CA 92113
Advanced Aqua Seal [®] 5C-4	50	5	7.50	Advanced Coatings and Chemicals 2213 N. Tyler Ave South El Monte, CA 91733

^aBased on 50-gallon quantity in 5-gallon containers.

Appendix A

MANUFACTURERS OF PROPRIETARY CLEAR, WATERPROOF MASONRY SEALERS

Product	Manufacturer
Aqua Pell [®]	Karlee Co. 412 Magnolia Ave Glendale, CA 91204
Advanced Aqua Seal [®] 5C-4	Advanced Coatings and Chemicals 2213 N Tyler Ave South El Monte, CA 91733
Chem Stop [®] HD	Chem Stop Corp. 9920 Flora Vista Bellflower, CA 90706
Hydr-o-pell [®] 1200	Chemprobe Corp. 2225 Belt Line Road/#323 Carrollton, TX 75006
Rhoplex [®] SS-521	Rohn and Haas Co. Independence Mall West Philadelphia, PA 19105
Super Kote [®] Clear	Ven-Chem Co., Inc. P. O. Box 3186 Santa Barbara, CA 93105

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 MCRD PWO, San Diego Ca
 NAS SCE, Barbers Point HI
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 NAVFACENGCOM Code 2014 (Mr. Taam), Pearl Harbor HI
 NAVMAG SCE, Guam
 NAVREGMEDCEN SCE, Guam
 NAVSECGRUACT PWO, Torri Sta, Okinawa
 NAVSHIPYD Code 400, Puget Sound, Code 410, Mare Is., Vallejo CA, PWO, Puget Sound, SCE, Pearl Harbor HI
 NAVSTA PWD (L. Ross), Midway Island, PWO, SCE, Subic Bay, R.P.
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